Comp. Biochem. Physiol. Vol. 83A, No. 1, pp. 197–198, 1986
Printed in Great Britain

0300-9629/86 $3.00 + 0.00

REVISED RESPIRATION RATES FOR THE SOUTHERN HARVESTER ANT, *POGONOMYRMEX BADIUS*

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(*Received* 14 *May* 1985)

Abstract—Respiration rates of *Pogonomyrmex badius* workers were very similar to other myrmicine ants, but 30 times less than previously reported (Golley and Gentry, 1964).

INTRODUCTION

Golley and Gentry (1964) published the first major paper on ant bioenergetics. It has been cited over 50 times in the last 20 years and still continues to be cited (Bernstein, 1982). Results of this paper indicated that harvester ant colonies allocate an unusually high proportion of their energy budgets to respiration. Based on this evidence, some authors proposed that ant populations act as an energy drain in ecosystems (Petal *et al.*, 1971). However, the respiration rates reported by Golley and Gentry (1964) were 10–30 times higher than rates for poikilotherms of similar size. Consequently, a number of authors have questioned the validity of Golley and Gentry's results (e.g. Hughes, 1970; McNeill and Lawton, 1970; Jensen, 1978). In order to resolve this discrepancy, I re-measured respiration rates of the Southern Harvester ant, *Pogonomyrmex badius* Latreille.

MATERIALS AND METHODS

Respiration rates were determined in modified Scholander constant pressure respirometers (Porter and Tschinkel, 1985). Preliminary tests indicated that worker respiration rates were independent of group size and the presence or absence of larvae. Twenty to 40 minor workers and 6–12 majors were used for each test run depending on the temperature. Oxygen consumption was measured at approximately 4 hr intervals for about 16 hr beginning 1 hr after placing the ants in the chambers. Following each respiration run ants were killed and dried at 60°C for 24 hr; they were then counted and weighed. Respiration rates were converted to standard temperature and pressure (STP).

Ants were collected in August and September 1984 from the upper 30 cm of the nest on the same day as the respiration runs. A different source colony was used for each replicate. Workers were a mixture of all age classes except that young callow workers were excluded. Brood samples consisted of minor worker pupae and larvae. Average live masses of majors, minors, pupae and larvae were respectively 32.7, 9.0, 13.4 and 10.4 mg; and corresponding dry masses were 12.1, 3.6, 3.0, and 2.7 mg. Workers were 33–44% dry mass, while larvae and pupae were 20–28% dry mass.

RESULTS

Harvester ant respiration rates increased exponentially with temperature (Fig. 1). Rates approximately tripled with each 10°C increase, although Q_{10}s dropped off slightly at higher temperatures. Total oxygen consumption of major workers was about twice that of minor workers (Fig. 1A) even though majors weighed almost four times as much. Minors consumed about 40–70% more oxygen than larvae and pupae.

Respiration rates per milligram dry mass are shown in Fig. 1B. As expected, minors had the highest metabolic rates followed in sequence by larvae and pupae. Majors averaged 40% less than minors per milligram of tissue. Major workers of *Solenopis invicta* (Porter and Tschinkel, 1985) and two species of *Atta* (Beraldo and Mendes, 1981) also showed similar declines in metabolic rates as worker size increased.

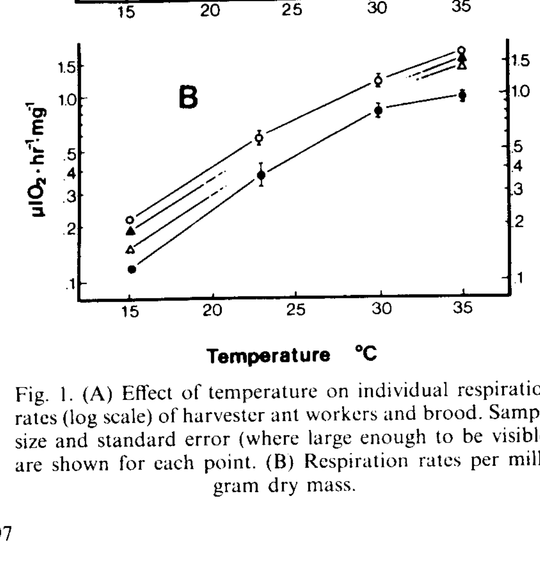

Fig. 1. (A) Effect of temperature on individual respiration rates (log scale) of harvester ant workers and brood. Sample size and standard error (where large enough to be visible) are shown for each point. (B) Respiration rates per milligram dry mass.

DISCUSSION

The respiration rates observed in this study were about 30 times less than those reported by Golley and Gentry (1964), but they were very similar to rates reported for other *Pogonomyrmex* ants (Ettershank and Whitford, 1973; Kay and Whitford, 1975; MacKay, 1982 and 1983), and myrmicine ants in general (Peakin and Josens, 1978). The cause of Golley and Gentry's error is uncertain but is probably related to their rudimentary respirometers which were no more than stoppered vials with a pipette inserted in one end. Also, they apparently underestimated minor worker dry weights by at least 50%.

Golley and Gentry (1964) calculated that the energy flow in *P. badius* colonies was between 14 and 48 kcal $m^{-2} yr^{-1}$ due to respiration. They noted that seed production (22 kcal $m^{-2} yr^{-1}$) in their study area was probably insufficient to support this rate of energy flow unless the harvester ants had other food sources. However, based on respiration rates reported in this study, energy flow due to respiration was probably closer to 1 kcal $m^{-2} yr^{-1}$. This revised estimate is well below estimated seed production and in the same range as reported by Rogers *et al.* (1972) for the Western Harvester ant, *Pogonomyrmex occidentalis*.

Acknowledgement—Thanks are extended to William P. MacKay for several helpful suggestions.

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